


An Analysis of the Civil Diving Population of the United States



**U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Manned Undersea Science and Technology**

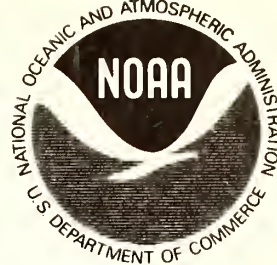
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U.S. DEPARTMENT OF COMMERCE

Rogers C.B. Morton, Secretary

National Oceanic and Atmospheric Administration

Robert M. White, Administrator

Manned Undersea Science and Technology

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A survey of this magnitude necessarily reflects the efforts of many individuals. The project leader was Karl Jugel of the Manned Undersea Science and Technology Office (MUS&T). Walter Leight, Director, Decisions Systems Branch, Technical Analysis Division (TAD) of the National Bureau of Standards, served as the Chief NBS coordinator and reviewer. Jonathan Bromberg, Ben E. Clayton, June Tuberg, and Harold Marshall, all of TAD, contributed to the data collection and preliminary analysis. Other principal reviewers included Nicholas Loope, Research Director, International Brotherhood of Carpenters and Joiners of America; Willard Searle of Searle Consultants; Robert Dill, Paul Stang, and Morgan Wells of the MUS&T Office. James W. Miller, Deputy Director of MUS&T served as final editor.

A handwritten signature in dark ink, reading "Donald C. Beaumariage". The script is cursive and fluid, with the first name "Donald" and last name "Beaumariage" clearly legible.

Donald C. Beaumariage
Director
Manned Undersea Science and
Technology

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INTRODUCTION

The Manned Undersea Science and Technology (MUS&T) Program of the Department of Commerce's National Oceanic and Atmospheric Administration was founded to "develop, promote, coordinate and support a national civilian operational capability for man to work under the sea to achieve better understanding, assessment, and use of the marine environment and its resources." The MUS&T Program includes the use of divers and existing undersea facilities (submersibles and undersea laboratories) in marine science projects.

In assessing the MUS&T Program and planning for an October 1972 workshop held by the National Academy of Science (NAS) and the National Academy of Engineering (NAE) to examine the needs for and applications of manned undersea activities, it became obvious that quantitative information on divers and diving activity was lacking. The applications of divers could be listed and various tasks in safety, diving physiology, and diver support equipment could be delineated, but information was lacking on the number of divers in various fields. The latest Federally published information, which addresses expenditures on diving and the commercial diving population, was contained in Marine Science Affairs, the April 1970 report by the President to the Congress on marine resources and engineering development. The estimates were made by a panel of experts for the National Council on Marine Resources and Engineering Development in 1968.

The Technical Analysis Division (TAD) of the National Bureau of Standards was enlisted to assist the MUS&T Program when it was found that an extensive data collection and analysis effort was required. The effort required became evident when it was found that individuals active in the various fields of diving, persons associated with the NAS/NAE effort, insurance companies, trade associations, and other individuals and organizations which might be expected to have summary data did not. TAD developed methodologies and collected information until a reduction in the MUS&T budget forced their participation to be terminated.

Diving was divided into four major fields (commercial, scientific, educational, nonmilitary governmental, and recreational). These fields were then further subdivided. After a summary of the findings, a section is devoted to each major field. In each section, the methodologies are explained to permit an evaluation of the accuracy of the estimates given.

* The information in this report is based on information gathered through January 1, 1973, with the exception of some commercial diving pay rates which are correct to January 1974.

DEFINITIONS AND SCOPE OF THE STUDY

For the analysis, a diver and categories of diving are defined as follows:

Diver -

Any individual in direct or clothing contact with the water who uses equipment which supplies a breathing gas mixture from a compressed source that enables the individual to breath underwater at ambient pressure.

Commercial Diver -

A diver who engages in diving in connection with non-training (of divers) employment with a "for profit" firm.

Scientific/Educational Institutional Diver -

A diver who engages in diving in connection with research, studies, or employment at an institution of higher education or associate degree (two year) awarding institution.

Nonmilitary Governmental Diver -

A diver who engages in diving in connection with direct employment by a nonmilitary Federal, state, or local government agency or a police or fire department (includes marine science and engineering).

Recreational Diver -

A diver who engages in diving solely for personal enjoyment without financial compensation.

These categories are further subdivided as discussed below.

The Commercial Diving category was divided into "Full-Time Payroll Employment" and "Free-Lance/Part Time." Individuals in the first category are paid whether diving or not and may be paid a fixed salary while diving and at a lower rate when not diving. To obtain information, major employers were contacted and sampling techniques were used. Individuals in the second category may be employed under one of three conditions but in each case are only paid for days on which diving is conducted.

The Scientific/Educational Institutional Diving category was divided into: "Colleges and Universities," and "Associate Degree Institutions and Research Consortia." These were then further subdivided into the type of individual diving, i.e., "Professional staff" or "student." Questionnaires were sent to all institutions listed in the Oceanographer of the Navy's "University Curricula in the Marine Sciences and Related Fields." Telephone calls were made to key non-respondents.

The Nonmilitary Governmental Diving was divided into "Federal, State and Local," "Police Departments" and "Fire Departments." Since there was no focal point for information on diving at the Federal level, agencies were extensively canvassed. At the "State and Local" levels, coastal and inland jurisdictions, including up to four organizations within the jurisdiction, were contacted and these data used to estimate the remainder. NBS had previously performed an effort for the Department of Justice's Law Enforcement Assistance Administration which sampled 1,400 of 13,000 law enforcement agencies and permitted estimating departments which utilize diving. A small sample was used to obtain estimates of the total number of divers and the number of fire department divers per state.

Recreational Diving was divided into "Individuals Capable of Diving" and "Individuals Engaging in the Sport," the former being those who have received formal or informal training and the latter being those who continue to dive after completing training. These data were obtained by contacting major training organizations and from a survey by Skin Diver magazine.¹

Three estimates of the population were made for each subdivision: the "Estimated Minimum Population," the "Most Likely Population," and the "Estimated Maximum Population." The upper and lower limits are based on a combination of computation and judgment on the part of analysts on the adequacy, completeness, and accuracy of the data obtained.

Geographic distribution was considered important in addition to nationwide estimates. Accordingly, the methods of data collection and analysis were designed to permit estimates on a regional basis. For the analysis, the United States was divided into four regions, which are illustrated in Figure 1:

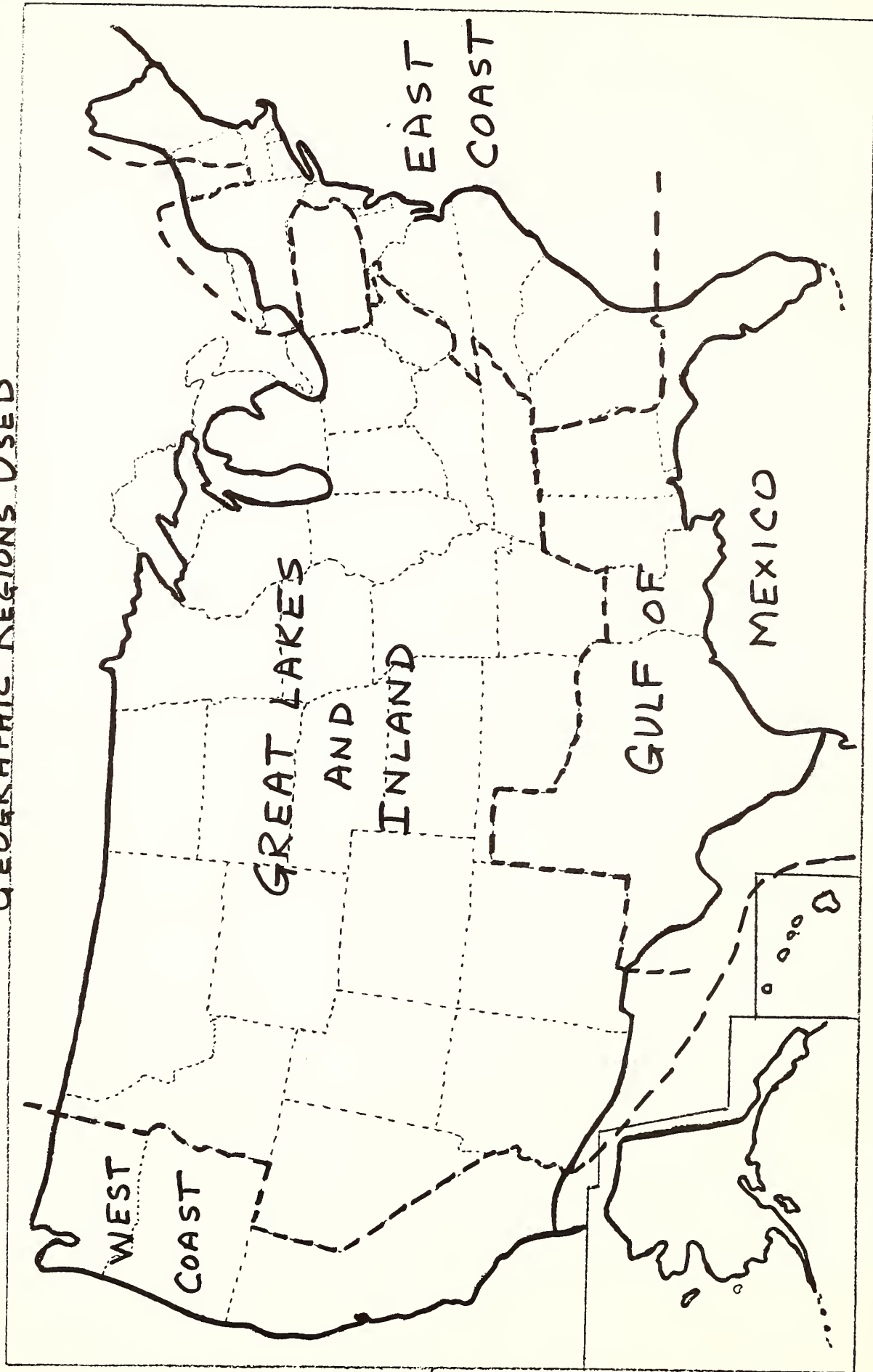
- East Coast (Maine to Georgia)
- West Coast (Including Alaska and Hawaii)
- Gulf of Mexico (Including Florida)
- Great Lakes and Inland

Florida was included in the Gulf of Mexico statistics. However, it was found that proportionately there is somewhat more diving on the east coast of Florida than on the west coast. Alaska and Hawaii were included in the west coast statistics because of limited information in these areas. The time differences, cost of data acquisition, and basic difficulty of obtaining information (particularly in Alaska) limited the effort which could be expended. For commercial diving, the locations of the firms' headquarters were used instead of field office and actual locations of diver activity.

The inquiries made to each firm, institution, agency, and organization included requests for information on activities, costs, health and safety, trends, and so forth. From these, it was possible to estimate an "average per diver expenditure per year." This was combined with related information to develop a rough approximation of annual U.S. expenditures for diving. For this analysis, the expenditures were categorized by purpose, such as "Marine Science and Engineering," rather than employer.

¹"1972 Skin Diver Reader Survey," Peterson Publishing Co., P4.

GEOGRAPHIC REGIONS USED



SUMMARY OF RESULTS

Table 1 summarizes on a nationwide basis the U.S. diving population giving estimated upper and lower limits (non-statistical) in addition to a "most likely population." Categories used are as previously defined. The first three categorizations are additive, while the fourth category can overlap any or all of the other three. It should be noted that in the second and third categories, diving is primarily a skill used by the individual, rather than a vocation.

TABLE 1

ESTIMATED U. S. CIVIL DIVING POPULATION

<u>Diver Categories</u>	<u>Estimated Population</u>		
	<u>Minimum</u>	<u>Most Likely</u>	<u>Maximum</u>
<u>Commercial</u>			
Full-Time Payroll Employment	1450	1530	1750
Free Lance/Part Time	650	775	1000
TOTAL	2100	2305	2750
<u>Scientific/Educational</u>			
<u>Institutional</u>			
Colleges and Universities			
Professional Staff	590	595	625
Students	1300	1360	1425
Support Divers	60	65	75
TOTAL	1950	2020	2125
Associate Degree Institutions and Research Consortia			
Staff	30	45	50
Students	230	250	280
Support Divers	15	25	30
TOTAL	275	320	360
<u>Nonmilitary Governmental</u>			
Federal Agencies	590	600	650
State and Local	300	335	500
Police Departments	6500	8060	9700
Fire Departments	2500	5000	7500
<u>Recreational</u>			
Individuals with Diving Skills	1,500,000	1,890,000	2,300,000
Individuals Practicing in the Sport	375,000	474,000	600,000

The following estimate of commercial divers was given in the April 1970 Marine Science Affairs:

COMMERCIAL DIVERS IN THE UNITED STATES

<u>Location</u>	<u>Number</u>
East Coast	150
Florida	100
Louisiana-Texas ¹	1,000
California ¹	250
Alaska	60
Total	1,560

¹Peak season in summer.

Source: Panel of Experts, 1968, National Council on Marine Resources and Engineering Development.

Included in the earlier estimate are those who work "part time." In addition, estimates of approximately two million active scuba divers and of training between 50,000 and 100,000 individuals per year were given. In comparison, the current analysis shows a greater number of commercial divers and a lower estimate of recreational divers. The estimated number of "individuals with diving skills" relates reasonably well to the earlier estimate of "active scuba divers." The earlier work did not define "active," but in a computation of expenditures it is inferred that "active" divers average ten dives per year.

Later information from five major recreational diver training organizations shows that prior to 1971 they had trained approximately 704,000 individuals but that only one in four or one in five individuals trained during 1970 and before continued diving after training when the novelty wore off. Thus, the earlier estimate was probably quite high. The conclusion regarding the rapid increase in recreational diving, however, was correct, as evidenced by rises in the approximate annual training levels to over 165,000 and over 226,000 in 1971 and 1972, respectively.

Table 2 provides the estimated geographic distributions of each category by geographic area using the "most likely" estimate from Table 1.

TABLE 2

GEOGRAPHIC DISTRIBUTION OF THE CIVIL DIVING POPULATION

Diver Category	East Coast	West Coast	Gulf Mexico	Great Lakes and Inland	Total
<u>Commercial</u>					
Full Time Payroll Employment	365	160	905	100	1530
Free Lance/Part Time	140	170	450	15	775
<u>Scientific/Educational</u>					
<u>Institutional</u>					
Colleges and Universities					
Professional Staff	195	195	160	45	595
Students	355	645	285	75	1360
Support Divers	15	35	15	0	65
TOTAL	565	875	460	120	2020
Associate Degree Institutions and Research Consortia*					
Staff	15	15	10	5	45
Students	50	170	15	15	250
Support	15	5	5	0	25
TOTAL	80	190	30	20	320
<u>Nonmilitary Governmental</u>					
Federal Agencies	165	190	120	125	600
State and Local	130	110	45	50	335
Police Departments	1260	670	900	5230	8060
Fire Departments	1300	500	500	2700	5000
<u>Recreational</u>					
	In Thousands				
Individuals Capable of Diving	300	790	480	290	1890**
Individuals Engaging in the Sport	75	198	120	73	474**

* Excludes Faculty and Students in Commercial Diving Training Programs

** Includes U. S. Citizens Outside of the Country

Table 3 provides the estimated annual expenditures on civil diving in the United States by purpose. It should be noted that prior tables were by employer. Because some organizations hold contracts with or grants from Department of Defense organizations, the estimates reflect some military spending. The estimates do not include military expenditures for diving by Defense employees.

TABLE 3

ESTIMATED ANNUAL EXPENDITURES FOR CIVIL DIVING BY PURPOSE

<u>Purpose</u>	<u>Expenditures</u> <u>(\$x1,000,000)</u>
Marine Science and Engineering (Government and Academic)	
Direct Diving Cost	2.6
Equipment and Replacements	0.3
Industrial Applications	
Diving Services (Worldwide)	63.1
Diver Equipment Replacement	2.0
Training	0.9
Recreational	
Basic Training Equipment	13.0
Advanced Equipment and Replacements	41.6
Personnel Expenditures	186.7
Public Safety	
Direct Diving Cost	3.3
Equipment and Replacement	2.6

The major differences between the current analysis and information in the following table from the April, 1970 Marine Science Affairs, are under "Science" and "Recreation":

**Estimates of Current Total Annual U.S. Expenditures on
Man-in-the-Sea**

[In millions of dollars]

1. Science (less than)-----	0.5
2. Defense:	
Diving training-----	4.5
Diver equipment-----	6.8
Man-in-the-sea -----	7.1
Diving operations (approximately)-----	25.0
3. Commercial (approximately)-----	45.0
4. Recreation:	
Personal expenditures ¹ -----	350.0
Diving equipment-----	22.5
Auxiliary equipment-----	25.0
Total (approximate)-----	486.4

¹ Estimated on the basis of 1.5 million divers, 10 dives each year, at cost of between \$20 and \$25 per dive.

Source: Derived from staff research, National Council on Marine Resources and Engineering Development, July 1969.

The difference between the earlier estimate under "Science" and the current analyses' estimate under "Marine Science and Engineering" is probably that the current analysis includes diving by government personnel for scientific and engineering purposes and, because of Department of Defense sponsorship of activities at colleges and universities, also includes some expenditures which were carried in the earlier effort under "Defense."

Expenditures on recreational diving equipment were estimated to be between \$40 and \$50 million in Marine Science Affairs. This agrees reasonably well with the current estimates of \$54.6 million for basic and advanced equipment. The major difference is in the "Personal Expenditure" category. The earlier estimate was based on 1.5 million divers diving ten times per year at a cost between twenty and twenty-five dollars per dive (\$23.33 was actually used). As noted earlier, the 2.0 million "active" divers was probably high and the actual "individuals with diving skills," as used in the current analysis, was probably not more than 1.0 million. Had 1.0 million been used, the early estimate would have been \$233 million if all of the 1.0 million averaged ten dives per year. If it had been assumed that only one in four continued diving, the earlier estimate would have been further reduced to slightly over \$58 million. While the current estimate of \$186.7 million is by no means exact, it is believed to be more realistic than the earlier estimate of \$350 million.

COMMERCIAL DIVING

Introduction

A "Commercial Diver," as earlier defined, is the employee of a "for profit" firm who engages in diving in connection with non-training (of divers) employment. In addition to including what is traditionally considered a "commercial diver," this definition also includes oceanographers or geologists who use diving in their work if employed by a "for profit" firm. In general, such employees use diving intermittently as a tool in their primary vocation. Specifically excluded were any individuals engaged in diver training regardless of the type of organization.

From marine science staff members who are divers, their peers, and their associates connected with commercial diving, there was prior knowledge of the commercial diving field on which to base the data collection and analysis. Commercial diving in the United States was estimated to be dominated by twelve to eighteen firms, of which perhaps six could be considered leaders. The remainder of commercial diving is performed by a large number of smaller firms. A major difference between large and small firms is the availability of facilities and equipment which permit the larger firm to perform a greater variety of work and to work at deeper depths.

Employment in the diving industry fluctuates with season and industrial factors. These latter factors include the sale of petroleum or gas field leases and field development; coastal, harbor, and estuary construction projects and the phase of construction; severe weather conditions and the need to inspect and repair facilities; and conditions which lead to the need for underwater salvage. Because of the fluctuations, divers are hired by commercial diving firms under one of the following conditions:

- Full-Time Payroll - paid a constant salary regardless of dive days or at one rate for dive days and at a lower rate for non-dive days.
- Exclusive Basis - employed by only one firm, but only paid when in a diving status.
- Contract - employed for the duration of a specific job or a specific contract, at the end of which the diver seeks another job.
- Day-to-Day - employed on a day-to-day basis or for a number of days required to complete a specific job. (Hiring is through lists maintained by unions and/or companies.)

Those employed under the last three conditions were grouped into a subdivision called "Free Lance/Part Time."

Two methods were used to obtain information on full-time payroll employment. The first involved contacting major firms; the second involved the sampling of firms listed under "Divers" in the "Yellow Pages" of telephone directories from various parts of the United States. Total full-time payroll employment was estimated by summing information from the large firms and adding to it the data obtained based on the sampling of small firms. A special analytic and sampling process, described later, permitted assessing the ramifications of using the "Divers" heading and also yielded useful information for analyzing "Free Lance/Part Time" employment. Data from labor unions was combined with data from the large firms and samples to develop the estimates for "Free Lance/Part Time" employment.

Major Firms Procedure

The MUS&T Program supplied the Technical Analysis Division (TAD) of the National Bureau of Standards (NBS) with a list of firms believed to be the major ones in commercial diving. NBS contacted each of these firms, making inquiries regarding employment, equipment, safety and business factors. The interviewers asked about other firms which the respondent considered "large" or a major competitor. This procedure was followed until no new firms were being added to the list, which finally contained fourteen names. Care was taken to differentiate between full-time employees and those hired under the other conditions listed previously. The following ten firms, in alphabetical order, reported employing a total of eight hundred and ninety-five divers on a full-time payroll basis:

<u>Firm Names</u>	<u>Headquarters Location</u>
Santa Fe Engineering & Construction Co.	Louisiana
Garrison-8 Divers & Marine Contractors, Inc.	Washington
International Underwater Contractors, Inc.	New York

<u>Firm Names</u>	<u>Headquarters Location</u>
J. and J. Marine Diving Company, Inc.	Texas
J. Ray McDermott Diving Division (Formerly Dick Evans Divers)	Louisiana
Ocean Systems, Inc.	Virginia
Oceaneering International, Inc.	Texas
Podesta Divers and Construction Company	California
Sub-Sea International, Inc.	Louisiana
Taylor Diving and Salvage Co. (Division of Halliburton, Inc.)	Louisiana

Three of the firms employ over half of the total. Information was supplied to the NBS with the understanding that it would be held in confidence; hence, no attempt was made to verify individual reports. It is possible that reports have been inflated or made conservative based on a firm's perception of the purpose of the study.

Estimate Developed from the "Yellow Pages"

To estimate the full-time payroll employment of firms not identified in the "Major Firms Procedure," the TAD utilized the telephone directory collection maintained by the Library of Congress. The firms listed under "Divers" were counted and noted for major cities, coastal cities or cities on major bodies of water for each state. Ninety-four percent of the directories were dated 1970 or later. The irregular arrival times of directories at the Library of Congress is partially attributable to there being approximately 1,892 different telephone exchanges in the United States in addition to the Bell Telephone System.

To avoid multiple counting and the counting of firms listed under "Divers," but not providing commercial diving services, several procedures were used, as follows:

- (1) Any firm which had an "out-of-state" address was not counted on the assumption that it would be encountered in its "home" state listing;
- (2) Each newly searched directory was examined to determine if any of the listed firms had already been counted from another directory in the same state, thus preventing double counting of firms listing themselves in cities within the state other than their "home" city;
- (3) Advertisements were carefully examined to categorize and count firms as "Apparent Commercial Diving Firms," "Sport Diver Schools," "Commercial Diver Schools," and "Sport Diving and Cruises." Equipment suppliers were counted separately;

- (4) Advertisements and listings were carefully examined by comparing telephone numbers to prevent double counting of firms which have a listing under more than one name or also under the name of the owner.
- (5) Firms which could be identified as divisions or subsidiaries of other firms, which would also be contacted, were not counted and the parent firm was asked for the overall total.

Information developed on the number of listing in each state is presented in Table 4.

TABLE 4
NUMBER OF LISTINGS UNDER "DIVERS"
IN YELLOW PAGES OF TELEPHONE DIRECTORIES BY STATE

State	State Total	Apparent Commercial Diver Firms	Sport Diver Schools	Comm. Diver Schools	Sport Diving and Cruises
Alabama	8	7	1	-	-
Alaska	2	2	-	-	-
Arkansas	4	3	1	-	-
Arizona	5	3	2	-	-
California	82	76	4	2	-
Colorado	2	2	-	-	-
Connecticut	7	7	-	-	-
Delaware	2	2	-	-	-
Florida	77	40	10	3	24
Georgia	6	6	-	-	-
Hawaii	3	3	-	-	-
Illinois	18	15	2	-	1
Idaho	1	1	-	-	-
Indiana	1	1	-	-	-
Iowa	0	-	-	-	-
Kansas	0	-	-	-	-
Kentucky	4	4	-	-	-
Louisiana	36	35	1	-	-
Maine	4	4	-	-	-
Maryland	9	9	-	-	-
Massachusetts	16	15	-	-	1
Michigan	12	12	-	-	-
Minnesota	7	6	1	-	-
Mississippi	3	3	-	-	-
Missouri	4	4	-	-	-
Montana	0	-	-	-	-
Nebraska	2	2	-	-	-
New York (State)	35	33	1	1	-
New Mexico	0	-	-	-	-
New Jersey	14	14	-	-	-
New Hampshire	1	1	-	-	-
Nevada	1	1	-	-	-
North Carolina	6	6	-	-	-
North Dakota	0	-	-	-	-
Ohio	22	19	3	-	-
Oklahoma	2	1	1	-	-
Oregon	7	7	-	-	-
Pennsylvania	12	10	2	-	-
Rhode Island	3	3	-	-	-
South Carolina	3	3	-	-	-
South Dakota	1	1	-	-	-
Tennessee	6	4	2	-	-
Texas	23	21	2	-	-
Utah	1	-	1	-	-
Vermont	0	-	-	-	-
Virginia	9	9	-	-	-
Washington	26	23	2	1	-
West Virginia	2	2	-	-	-
Wisconsin	4	4	-	-	-
Wyoming	0	-	-	-	-
District of Columbia	<u>2</u>	<u>2</u>	<u>-</u>	<u>-</u>	<u>-</u>
TOTAL	495	426	36	7	26

Regional random samples were selected from the lists of firms which had not been contacted in conjunction with the effort to identify the ten largest firms. As can be seen in Table 5, one hundred and three contacts were attempted and of these, ninety-five were successful. Fifty-four of these firms, or approximately fifty-seven percent, reported divers on their full-time payroll while 41 firms did not.

TABLE 5
REGIONAL TELEPHONE LISTINGS OF COMMERCIAL
DIVING FIRMS AND SAMPLING OF SUCH FIRMS

Region	No. Diving Firm Listings	No. Contacts Attempted (Excl. "10 Largest")	No. With Disconnected Telephone	No. With At Least One Diver*	Per Cent With Divers*	No. of Divers* Reported	Avg. No. Per Firm	Reporting No Divers*
East Coast	122	29	1	15	53.6	45	3.0	13
West Coast	111	18	0	11	61.2	20	1.8	7
Gulf of Mexico	106	43	6	21	56.8	89	4.2	16
Great Lakes & Inland	87	13	1	7	58.3	15	2.1	5
TOTAL	426	103	8	54	56.8	169	3.1	41

* "DIVER" MEANS ON THE FIRM'S FULL-TIME PAYROLL.

The results of the contacts can be extrapolated to estimate the full-time payroll employment of firms not contacted assuming that the sampled firms are representative of all firms within the same region. It should also be noted that a significant number of commercial divers, whose numbers are estimated independently later, are employed on other than a full-time payroll basis. A review of listings resulted in the development of a non-overlapping list of firms. The extrapolated estimate, therefore, should be close to the actual population. Statistics derived from the sampled group are applied to the total group as shown in Table 6.

TABLE 6

COMPUTATION TABLE FOR UNCONTACTED "SMALLER FIRMS" FULL-TIME PAYROLL EMPLOYMENT

Region	No. Not Contacted (NC)	Disconnect Rate (PR)* (%)	Potential Disconnect NCxPR=PD	Firms To Be Est. NC-PD=F	Per Cent Having Divers* (R)	No. Est. To Have Divers FxR=NF	Avg. Divers Per Firm (AD)*	Est. No. Divers NFxAD
East Coast	93	3.4	3	90	53.6	48	3.00	144
West Coast	93	0	0	93	61.2	57	1.82	103
Gulf Coast	63	14.0	9	54	56.3	30	4.24	1127
Great Lakes & Inland	74	7.7	4	70	58.3	40	2.14	85
Total	323	---	16	307	---	175	---	459
National	323	7.8	25	298	56.8	169	3.13	528

* From Table 5

The estimate of full-time payroll employment by region can be made by summing the number of individuals reported by the "largest firms," the number reported by sampled firms, and the estimate made for uncontacted firms. This information is given in Table 7.

TABLE 7

Estimated Total Full-Time Payroll Employment

Element	East Coast	West Coast	Gulf of Mexico	Great Lakes & Inland	Total
Largest Firms	175	35	685	0	895
Sampled Firms	45	20	90	15	170
Uncontacted Firms	<u>145</u>	<u>105</u>	<u>130</u>	<u>85</u>	<u>465</u>
TOTALS	365	160	905	100	1530

It should be noted that the region is by the location of a firm's headquarters and is not necessarily where the diving is conducted. It is estimated, considering related information from unions' locals and indications from firms, that the actual number is not likely to be less than 1450 nor more than 1750.

Impact of Using the Heading "Divers"

The "Yellow Pages" sampling described was based on divers being listed as such in the telephone directories. To determine whether firms other than those listed in directories under "Divers" also employ full-time commercial divers, special samples were taken in the following areas:

New York City
 New Orleans-Morgan City, La.
 Los Angeles-San Diego, Calif.
 Seattle, Washington

The following listings were checked in addition to those already identified:

Marine Contractors (Contractors, Marine)
 Pile Driving
 Docks-Dock Building
 Dredging
 Marine Salvage (Salvage, Marine)
 Marine Engineers (Engineers, Marine)

In the marine engineers category, several variations of listings were checked to assess the number of oceanographers, geologists, and engineers who use diving in their work with "for profit" firms. The method was not successful, so the data may be incomplete for such individuals.

Table 8 summarizes the total number of listings examined for the four regions. It also indicates the total number of unique listing (counting a company listed under two or more headings only once), the sample size used, and findings regarding the employment and use of divers. In the method used

to determine "Unique Listings," a hierarchy of headings was established, using the order shown above. Thus, a firm listed under "Divers," "Marine Contractors," and "Marine Salvage" would only be counted as a "Unique Listing" under "Divers." Similarly, a firm listed under "Marine Contractors" and "Pile Driving" would only be counted as a "Unique Listing" under "Marine Contractors."

TABLE 8

SAMPLING OF "NON-DIVER" FIRMS FOR FULL-TIME COMMERCIAL DIVERS

Area	Total of All Listings ¹	No. of Unique Listings ²	No. Unique Non-Diver Listings	No. Non-Diver Sampled Successfully	No. Not Using Diver	No. Reporting F.T. Divers	No. Reporting Use Of Diving Contractor	No. Reporting Use Of Independent InDivers
New York City Area	148	127	113	41	26	0	9	6
New Orleans-Morgan City, La.	153	117	92	38	16	0	17	5
Los Angeles-San Diego, Calif.	55	44	30	15	7	2	4.5	1.5
Seattle, Washington	75	52	37	20	4	6	1	9

1 - Divers; Marine Contractors; Pile Driving; Marine Salvage; Dredging; Docks-Dock Building; and Marine Engineers

2 - Counting firms listed under more than one heading only once.

In New York and New Orleans-Morgan City it was found that for all headings except "Marine Salvage," at least one firm with a "Unique Listing" used diver services. Firms using divers which were listed under "Marine Salvage" were also listed under "Divers." Thus, it can be reasonably assumed for the East and Gulf Coasts that the use of additional headings would not yield a significant increase in the estimate of divers. It was also found that the majority of firms using diver services obtain these services through a commercial diver firm.

In the Los Angeles-San Diego area, it was found that a firm listed under "Marine Contractors" and "Pile Driving" employed one man who dives and a firm listed under "Marine Engineers" employed two men who dive. In the first case, the employee had basically non-diver duties in pile driving and was called upon ten per cent or less of his time to perform diving duties. In the second case, the firm (one of five sampled and ten listed) had two scientists who were qualified SCUBA divers and used these skills for particular studies requiring diving. It can be assumed for Southern California that the use of additional headings would not yield a substantial increase in the number of commercial divers. A high reliance on contract diving services was found among firms using diver services.

In Seattle, it was found that six firms not listed under "Divers" had employees who dive. Using the headings, there were three "Marine Contractors" with such employees and one firm each under "Pile Driving," "Docks Building," and "Marine Salvage." It was found that all of the subject firms listed under "Marine Contractors" were also listed under "Pile Driving" and that the employees were in fact pile drivers. It was found that for the firms listed under "Dock Building," that the owner was the diver and he used his skills where he would otherwise contract or hire an occasional independent diver for the work. The firm listed under "Marine Salvage" reported its employees were involved in scientific diving, not salvage. Rearranging the hierarchy for Seattle would yield sixteen "Unique Listings" under "Pile Driving" and seven "Unique Listings" under "Marine Contractors," with all of the firms reporting employees who dive being listed under "Pile Driving." It was also found that there is little reliance on contract diving services among firms using diver services in the Seattle area. Therefore, by not using the heading "Pile Drivers" in addition to "Divers" in Seattle, the estimate of divers on the payrolls of firms is low. From the comments made, this appears to be a local practice.

Based on these checks, the use of the heading "Divers" seems to be valid. It, therefore, can be assumed that the estimates made using firms listed under this heading will be very close to the actual full-time commercial diving populations and only slightly conservative.

Free-Lance/Part-Time Divers

A "Free-Lance/Part-Time Diver," as used in this analysis, may be associated with one firm, or move from job-to-job. In either case, there is considerable room for error. To develop the estimate, two methods were used. The first involved contacting unions which represent divers and the second combined surveying and sampling data for the Gulf of Mexico region.

Several organizations in the United States represent divers; these include the International Association of Professional Divers (New Orleans), the Pile Drivers and Divers Association (Long Beach, Calif.) and locals affiliated with the United Brotherhood of Carpenters and Joiners Unions of America. Cooperation was exemplary from the latter organization and its locals. Locals were asked about the number of divers employed intermittently and the degree to which divers in their area were organized. Information on full-time employment was not used directly because information from firms employing divers and using diving services indicated that these individuals were more than likely counted through the survey and sampling.

TABLE 9Diver Membership Reported by Locals AffiliatedWith the United Brotherhood of Carpenters and Joiners Union of America

REGION	NO. OF LOCALS CONTACTED	NO. OF LOCALS REPORTING	NO. WITH NO DIVERS	NO. OF DIVERS EMPLOYED FULL- TIME	NO. OF DIVERS EMPLOYED INTERMITTANTLY	UNIONIZATION
EAST COAST	24	21	6	99	123	HIGH
WEST COAST	6	6	0	166	148	HIGH
GULF OF MEXICO	15	15	2	110	85	MIXED
GREAT LAKES AND INLAND	11	11	6	31	10	HIGH
TOTAL	56	53	14	406	366	

It was generally believed that information from the union locals would allow valid estimates to be made for all areas except the Gulf of Mexico.

Union and diving firm contacts generally agreed that divers in the Gulf of Mexico region (with the exception of Florida) are far less unionized than in other areas. Since the total number of divers employed through firms in the regions mentioned is not exactly known and will fluctuate, it is impossible to state exact percentages of union and non-union divers. However, it seems safe to assume that at least seventy-five per cent of the divers employed through the region and who are not providing services to the non-diver firms contacted are not unionized.

Since diving firms contacted during the "Yellow Page" analysis of full-time payroll employment were also queried on their use of free-lance and part-time divers, a gross total was obtained. This number is meaningless since it was found that some of these divers work only for one firm, while others may work for several firms during a year and would be counted more than once. Based on the information from the non-diver firms and the unions, the only region where sole reliance on union-supplied data would lead to substantial under-estimation would be the Gulf of Mexico (excluding Florida). Thus, further analysis of information from diving firms was limited to the Gulf of Mexico region.

An attempt was made to determine for how many firms the same Free-Lance/Part-Time diver might work during a year. Without sampling the divers themselves, it was necessary to rely on information supplied by firms contacted during the survey of large firms and the sampling of other firms. It was estimated that freelance divers would associate with two or three firms, with five firms considered to be the general maximum for all but a few individuals.

It was found that five large firms employed between three hundred and five hundred Free-Lance/Part-Time divers. In several cases, the firms reported that the divers were employed exclusively by the firm, but only paid when diving was to be conducted. Adjusting for multiple reports of the same individual, it is estimated that approximately two hundred individual divers are involved, with there being no less than one hundred and fifty and no more than three hundred and fifty.

From the information obtained during the sampling of firms from the "Yellow Pages" it was possible to derive statistics which could be applied to the uncontacted firms. It was found that approximately forty-two per cent of the firms listed use Free-Lance/Part-Time divers and that of these approximately twenty per cent have exclusive arrangements with the diver. Combining information from firms with the information from the unions, yields an estimate of Free-Lance/Part-Time population by region, given in Table 10. The actual total population would not likely be less than six hundred and fifty nor more than one thousand.

Table 10

Estimated Free-Lance/Part-Time Employment
By Geographic Area

	East Coast	West Coast	Gulf of Mexico	Great Lakes & Inland	Total
Union Members	125	150	85	10	370
Non-Union Members	<u>15</u>	<u>20</u>	<u>365</u>	<u>5</u>	<u>405</u>
Total	140	170	450	15	775

Diver Pay Scales

Firms were only queried in general terms about pay scales for their divers. The variations in conditions under which divers are employed and individual differences among divers make it extremely difficult to generalize for non-union divers. Union contracts covering divers are more explicit on minimums that must be paid. A union diver supplying his (or her) own equipment generally rents the equipment at a separately negotiated rate.

For a diver on the full-time payroll, the annual minimum salary is between \$10,000 and \$15,000 per year. A highly skilled diver with a large firm can earn in excess of \$25,000 per year. Without an extensive survey it was impossible to estimate the distribution of salaries. Non-union divers on other than a full-time basis are hired for between \$50 and \$100 per diving day, with the rate tending to be closer to the upper end of the range.

Union divers in the New York (N.Y.) area, which extends for union business south to Wilmington, Delaware and includes New Jersey (Philadelphia is not included), are members of the Marine Divers and Tenders Union Local No. 2295. The local is affiliated with the United Brotherhood of Carpenters and Joiners Union of America.

The base pay scale reported for a New York diver is \$11.11 per hour or \$88.88 per day to which is added \$3.21 per day for fringe benefits covering welfare, pension, annuity, and vacation.* In addition, there is a daily premium based on water depth, added to the base pay scale as follows:

<u>Depth</u>	<u>Premium**</u>
<u>Air Dives</u>	
0 - 59 feet	No depth rate
60 - 74 feet	22¢/ft/day
75 - 125 feet	70¢/ft/day
Over 125 feet	Negotiated with Company
<u>Mixed Gas Dives</u>	
0 - 74 feet	No depth rate
75 - 125 feet	70¢/ft/day
Over 125 feet	Negotiated with Company

These pay rates do not include equipment. Divers who furnish their own equipment may charge additionally as much as \$25 per day. A tender on the surface reportedly costs an additional (approximately) \$60 per day in pay and benefits.

After six months of membership in the union, divers are reported to qualify for the same \$30,000 life insurance coverage as other union members. New York State residents are covered by workman's compensation for cases of on the job injury.

Union divers in the Los Angeles (L.A.) area, for the most part, are members of Local 2375 of the Pile Drivers, Bridge, Dock and Wharf Builders Union. The union is affiliated with the United Brotherhood of Carpenters and Joiners Union of America.

The base pay scale reported for a diver in construction work is approximately \$150.00 per day to which is added \$19.28 in fringe benefits. In addition, there is a daily premium based on water depth, reported to be as follows:

* These figures are in effect until June 30, 1975.

** As of January 14, 1974.

<u>Depth</u>	<u>Premium*</u>
50 - 100 feet	\$1.00/foot/day
100 - 150 feet	\$1.50/foot/day
150 - 200 feet	\$2.00/foot/day
200 - 225 feet	\$3.00/foot/day
225 - 250 feet	\$4.00/foot/day
250 - 275 feet	\$8.00/foot/day
Over 275 feet	Negotiated, but at least \$10/ft/day

There is also hazard pay for entering tunnels and pipes, as follows:

<u>Entrance Distance</u>	<u>Premium*</u>
5 - 50 feet	\$2.30/foot/day
50 - 100 feet	\$4.60/foot/day
100 - 150 feet	\$9.15/foot/day

These pay rates do not include equipment. Divers who furnish their own equipment negotiate a separate rental fee. A tender on the surface reportedly costs an additional \$7.46 per hour plus \$1.90 per hour in fringe benefits.

Industries Using Diver Services

Two sources were used to determine which industries are users of diver services: the commercial diving firms which were conducted and the other firms sampled in the procedure to locate previously uncounted divers. Very few commercial diving firms keep, or will release, quantitative information on their major customers and very few customers keep careful track of their diver utilization. Thus, typical responses would be "our business is mostly oil, with some construction, and a little salvage every so often" or "we use divers a couple of days at a time, a couple of times a year." Attempts were made to have respondents attach percentages to terms such as "mostly" or to state "we used a diver twice last year for one day one time and three days the other." An attempt was made to develop weighted averages within each region, and then a weighted average nationally. Because of the poor quality of the source information, the estimates should be considered very "rough."

For the analysis, users were classified as follows:

- Petroleum and Natural Gas - including support of drilling, performing undersea connections, pipeline installations and jetting, and platform and pipeline inspection.
- Construction - including work on bridge and structure foundations, cofferdams and water intakes and the performance of periodic repairs and inspections.
- Salvage and Ship Repairs - including the salvage of ships and other lost equipment and the performance of hull and machinery cleaning repairs, and inspections.

* As of January 14, 1974.

- o Other - such as diving instruction; cable laying; underwater TV and photography; metal detection; demolition and wrecking; collection of sponges, abalones, and king clams; and research and development.

Seven of the ten largest firms (based on full-time payroll employment) and the firms hiring large number of free-lance/part-time divers, reported that most of their work was in support of the petroleum industry. The four which cited percentages gave them as ranging from 80% to 100%. A reply of "mostly oil" was acknowledged by respondents to mean at least three quarters. Six of the seven firms doing "mostly oil" work are headquartered in the Gulf of Mexico. The other firms in the list of ten largest reported that their work was distributed in various fields, including petroleum. One firm indicated its work was mainly in construction and minimally for the petroleum industry. It is also interesting to note that three of the seven firms supplying services to the petroleum industry provide substantial amounts (over 25%) of these at overseas locations. The other four firms supply overseas services occasionally.

Three-quarters of the commercial diving firms in the New Orleans-Morgan City area supply their services primarily to the petroleum industry; the remaining quarter reported no petroleum work. These latter firms service the construction industry and the salvage industry, approximately equally. Of the firms servicing the petroleum industry, approximately two-thirds (representing but 1/4 of the offshore oil diver population) reported no overseas business. With the exception of Southern California, providing services for construction predominates in other areas, with there being substantial services used in salvage and ship repairs. It should be noted that the respondent often perceived that business data could be of use to competitors, hence information supplied for a study of this type tends to be general in nature. As a result, the data presented are considered a very broad approximation. Table 11 shows the Estimated Percentage of Commercial Diving Services Used by Industries by Region.

TABLE 11

Estimated Percentage of Commercial Diving Services Used by Industries

<u>Industry</u>	<u>East Coast</u>	<u>West Coast</u>	<u>Gulf of Mexico</u>	<u>Great Lakes & Inland</u>	<u>Weighted National Average</u>
Petroleum and Natural Gas	20	22	82	0	56
Construction	37	40	6	65	20
Salvage and Ship Repair	31	28	11	19	18
Other	12	10	1	16	6

A recurring comment made was that the diver had to be more than just a diver. Good mechanical aptitude, experience with tools, and experience on the equipment being used on were considered essential. In the vast majority of activities reported, surface breathing gas supplies are used to increase bottom time. The following are representative operations divers are expected to perform:

- Application of expoxy and other coatings
- Cable laying, inspection, and maintenance
- Demolition and wrecking
- Equipment installation (electrical and mechanical)
- Freeing fouled screws
- Hull inspection, cleaning, and maintenance
- Inspection, maintenance and repair of foundations and structures
- Inspection, maintenance and repair of intakes, outfalls, tunnels, and dams
- Installation of scientific sensors
- Installation of stern bearings
- Oceanographic and geological sampling and measurements
- Photographic and video tape surveys
- Pile driving
- Pipeline jetting, inspections, maintenance, and repairs
- Repairs to propeller shafts, propellers, and rudders
- Search and Salvage
- Ultrasonic measurements
- Welding, cutting, and burning

Commercial Diver Training

Ten organizations were identified where training in the industrial skills for commercial diving can be obtained; seven are training firms, two are institutions which award associate degrees and one is a prison. They are as follows:

- Coastal Diving Academy, New York, N.Y.
- Coastal School of Deep Sea Diving, Oakland, Calif.
- Commercial Divers Center, Wilmington, Calif.
- Divemasters, Inc., Madison, Wisconsin
- Divers Institute of Technology, Seattle, Wash.
- Divers Training Academy, Fort Pierce, Fla.
- Oceaneering International, Commercial Diver Training Division, Houston, TX
- Highline Community College, Seattle, Wash.
- Santa Barbara City College, Santa Barbara, Calif.
- California Institution for Men, Chino, Calif.

TAD made contact with eight of these organizations. Their programs tend to stress such industrial skills as cutting and welding and the use of diving and support equipment. Some training in the marine sciences is common. SCUBA training is given, but primary emphasis is placed on surface supply systems. The use of chambers and mixed gas is also generally taught. There is usually considerably greater practice than classroom training (e.g. two-thirds practice, one-third classroom). The duration of courses ranges from three months (private schools) to two years (associate degree institutions).

Two large organizations reported training between one hundred and eighty and two hundred individuals each per year; four others approximately one hundred each per year. It appears that as many as eight hundred and fifty individuals (approximately) are trained in industrial diving skills each year by civil organizations. Of these, approximately 15% are in programs of associate degree granting institutions.

In addition to the industrially oriented programs, nine associate degrees institutions prepare marine science technicians capable of using diving in support of their work. These programs will be discussed under "Scientific/Educational Institutional Diving."

Commercial Diving Expenditures

Diving and diving equipment dollar value statistics are continually collected by the Federal Government under business data programs. These data are not maintained nor compiled separately, but are included in an "other" or "miscellaneous" category. Diving firms were queried on their revenues resulting from diving activities, on costs, and on capital investments. The information supplied by them, however, is scant and is considered to be questionable. Table 12 summarizes the information obtained from this survey. For this purpose, estimated personal expenditures were simply multiplied by the estimated number of divers. Divers were classified as follows for the estimate:

"Full-Time Payroll, large firm"

"Full-Time Payroll, small firm (including owner-diver firms)"

"Intermittant, large firm"

"Intermittant, small firm and independent"

Training expenses are estimated to average \$1,100 per new individual trained per year. Using this and the prior estimate of eight hundred and fifty trainees per year, results in an estimated annual training expenditure of \$935,000.

TABLE 12

Estimated Annual Expenditures for Commercial Diving

	Estimated Number (N)	Estimated Total Annual Charge For Services/Diver (C)	Estimated Total Annual Expenditures (NxC) \$M	Est. Annual Expenditure For Equip./Diver (E)	Est. Total Annual Equip. (Nx E) \$M
Full-Time Payroll, Large Firm	395	\$32,500	29.1	\$1,200	1.1
Full-Time Payroll, Small Firm	635	\$27,500	17.5	\$ 700	0.4
Intermittant, Large Firm	200	\$25,000	5.0	\$ 900	0.2
Intermittant, Small Firm & Independent	575	\$20,000	11.5	\$ 500	0.3
TOTAL	1805		63.1		2.0

Introduction

A major element of the MUS&T Program is providing facility (submersible and undersea laboratory) support to marine scientists and engineers who use manned underwater activities. Individuals supported have come from government, industry, and "academia." A questionnaire was sent to one hundred and twenty-seven colleges, universities, associate degree institutions, and research consortia listed in the August, 1971, edition of the Oceanographer of the Navy's pamphlet, "University Circula in the Marine Sciences and Related Fields." From responses to the questionnaire or telephone inquiries made to key non-respondants, information was obtained from approximately eighty-three per cent of the total.

For the analysis the following types of divers were defined:

Support/Helper Divers - divers employed by the institution to support scientists, engineers, and students who dive or to install sensors or to take samples for scientists, engineers and students, or to service or maintain equipment or facilities operated by the institution.

Faculty/Research Associate Divers - members of the faculty or staff engaged in research and/or teaching (except teaching diving) who use diving skills in support of their activities.

Scientific/Technical Student Divers - graduate and junior and senior year undergraduate students (of other than diving) who use diving skills in support of their educational or research programs.

Marine Science Divers - students of associate degree institutions who are enrolled in a marine science technical program in which diving skills are a major factor.

Students of commercial diving (industrially used skills) were counted earlier and have been reported in the section on commercial diving.

In addition to information about numbers of divers, the following data were also sought: the average number of days per year diving conducted by individuals in each category; the geographic areas and bodies of water in which operations are conducted; the schools or departments within the institution which use divers; and whether an individual was designated as a "Diving Officer" (or similar title), who supervises diving.

Colleges and University Divers

Of the one hundred colleges and universities contacted, using questionnaires or the telephone, information was obtained from eighty-seven. Of the eighty-seven, only nine reported no diving activities. Table 13 shows the responses by geographic location.

TABLE 13

Responses from Colleges and Universities
by Geographic Area

Response	East Coast	West Coast	Gulf of Mexico	Great Lakes & Inland	Total
Reported Divers	29	23	16	10	78
Reported No Divers	5	2	2	0	9
Did Not Respond	10	0	3	0	13
Total	<u>44</u>	<u>25</u>	<u>21</u>	<u>10</u>	<u>100</u>

Of the institutions reporting diving activities, thirty-two reported that ten to forty-nine members of the professional staff and students dive, another eight reported fifty to ninety-nine; and five reported one hundred or more. Institutions reporting at least one hundred in alphabetical order are:

University of California (Berkley)
University of Hawaii
University of Miami
Scripps Institute of Oceanography
University of Washington

Institutions reporting fifty to ninety-nine, in alphabetical order, are:

University of California (Davis)
Florida Atlantic University
Long Island University (all campuses combined)
University of Michigan
Texas A&M
United States Naval Academy
Virginia Institute of Marine Science
Woods Hole Oceanographic Institution

Because there were a significant number of non-respondents in the East Coast and Gulf of Mexico regions, population estimates were made for non-respondents in these regions. The following assumptions were made:

- the non-respondents are those programs involving less than ten staff members and students;
- the same proportion of non-respondents would have divers as the institutions in the region which responded to the questionnaire;
- the non-respondents would have the same average numbers of professional staff members and students as other institutions in the region with less than ten professional staff and students who use diving.

For the East Coast, ten institutions did not respond. Of thirty-four institutions responding to the questionnaire, twenty-nine reported divers. It is estimated eight of the non-respondents would have divers. It was also computed that institutions with less than 10 divers averaged 2.3 professional staff members and 2.2 students who used diving. These were multiplied by the estimated non-respondents with divers to obtain an estimate of eighteen staff members and seventeen students. A similar procedure was followed for the Gulf of Mexico region.

Table 14 summarizes the results of the questionnaires, the telephone inquiries, and the estimates of divers at colleges and universities.

TABLE 14

College and University Divers
by Geographic Area

Type	East Coast	West Coast	Gulf of Mexico	Great Lakes & Inland	Total
Faculty and Research Associates	195	195	160	45	595
Students	355	645	285	75	1360
Support/Helper Divers	<u>15</u>	<u>35</u>	<u>15</u>	<u>0</u>	<u>65</u>
Total	565	875	460	120	2020

Tabulations were also made which show by region the characteristics of the diving programs at colleges and universities. These are summarized in Table 15.

TABLE 15

Characteristics of College and University Diving Programs
by Geographic Area

	East Coast	West Coast	Gulf of Mexico	Great Lakes & Inland	Total
Number With Diving Activities	29	23	16	10	77
Number With 10 or More Divers	15	17	11	2	45
Number With 10 or More With Diving Officer	10	14	10	1	35
Number With Less Than 10 With Diving Officer	3	2	1	1	7
Number Using Waters In or Off Home State Only	9	16	5	1	31
Number Using Foreign Waters	8	5	5	5	23

College and University Departments Using Diving

Information was requested about the departments or schools within the institutions which use diving. This information was obtained from all but about 15% of the institutions. Because the questionnaire did not provide standard descriptions, a wide range of responses were received. For instance, some respondents used such terms as "biology" broadly, while other differentiated between "biology" and "zoology." The term "biology" was used by nearly half of the respondents, the term "geology" by nearly one-third, "geosciences" and "zoology" by roughly 10% each and roughly one-fifth states "marine sciences." To permit comparisons, a set of "standard" descriptions was developed after the fact, as follows:

Biosciences - biological sciences, biology, zoology, genetics, and related fields dealing with living aquatic organisms.

Geosciences - earth sciences, geology, geophysics, and related fields.

Marine Sciences and Oceanography - interdisciplinary programs that include elements of biosciences, geosciences, physical oceanography, water chemistry, and resource programs.

Diving Physiology and Medicine - diver physiology, diving medicine, and diver communications.

Engineering - ocean, marine, civil, chemical and related fields of engineering.

Other - physics, archeology, etc.

Of the sixty-five institutions reporting, twenty-six institutions indicated that only one department or school used divers. For twelve, this department was "Marine Science and Oceanography" and for eleven "Biosciences." The following are the number of times each "department" was indicated³:

Biosciences	-	43
Geosciences	-	30
Marine Science/Oceans	-	27
Diving Phy./Medicine	-	5
Engineering	-	10
Other	-	4

College and University Diver Training

The questionnaires and telephone calls did not ask what type of training was required before an individual could use diving as part of a program at the institution. However, some information on training requirements was furnished by respondents. While some institutions with small numbers of individuals using diving do not impose minimum training requirements, it

³ Since a college or university could indicate more than one "department," these are not additive.

appears that most institutions require at least the equivalent of certification by one of the national recreational diver training organizations. The divers at institutions obtain this training under one of the following types of programs:

- a. Independent courses offered by a national recreational diver training organization (on or off campus)
- b. Courses offered through the Physical Education Department by an instructor affiliated with a national recreational diver training organization which yields both institution and nationally recognized certification.
- c. Independent diving courses offered through the Physical Education Department.
- d. A course offered through a campus diving club which is taught by an instructor affiliated with a national recreational diver training organization and which yields both institution and nationally recognized certification.

Programs offering both institutional and nationally recognized certification seem most common. The reason may be that nationally recognized certifications permit students to continue diving in the course of their work after they leave the institution. Institutions with large programs often superimpose additional training requirements, particularly for such specialized techniques as use of undersea facilities and saturation diving. It should be noted that the student is fundamentally a biologist, geologist, etc. and that diving is only a tool, not the primary course of study.

College and University Expenditures on Diving

When diving is an essential element of a course of study or in a research project, "expenditures" can be estimated either as the total cost of the course or research or only in terms of the direct cost of the diving itself. For instance, a \$100,000 research effort composed of salaries, laboratory efforts, computer time, surface based data collection, data analysis, publication and \$10,000 of diving costs for data collection, could be considered as a diving "expenditure" of \$100,000 if the diving were absolutely essential for completing the research, or only a \$10,000 "expenditure." For this analysis, the latter interpretation was adopted. The questionnaire asked for the average number of days on which diving operations were conducted by the "average individual" for each type of diver. The interpretations and responses were quite variable.

An overview of the responses shows that a rough "average" nationwide is in the range of fifteen to twenty-five days of diving per individual per year. The direct cost of the diving itself lies between \$20 and \$25 per day. Using the estimated number of divers, the approximate expenditure each year is \$900,000. Various Federal programs in marine sciences and engineering

are the source of the research funds which support projects involving diving. It is estimated that approximately \$600,000 per year is spent by NOAA and others to support operations involving the use of divers. Thus, expenditures total approximately \$1.5 million per year. If it is assumed that the institution replaces equipment for the professional staff and that the average annual cost is \$200 per staff member, there is an additional expenditure of approximately \$109,000. Specialized equipment used by students may average another \$25 per student per year, for an expenditure of approximately \$25,000.

Associate Degree Institution Diving

Fourteen of nineteen institutions which award associate two-year degrees in marine technology responded, of which ten indicated diving activity. Two of these, Highline Community College and Santa Barbara City College, indicated only commercial diving programs and were reported in the section, "Commercial Diver Training."

In identifying divers at associate degree awarding institutions, an attempt was made to distinguish between faculty and students who use diving incidentally to their primary purposes and those engaged in programs where diving skills are a major factor, such as marine science diving. For eight institutions, a total of sixteen faculty members and one hundred and fifty-five students were reported in the first category and a total of five faculty and forty-five students in the latter. Use of seventeen support/helper divers was also reported. (Geographic distribution is combined with research consortia information in Table 16).

Diving is usually conducted in local waters. Five of eight institutions have a Diving Officer. Students generally take an initial diving course as part of Physical Education and then either use diving to support their studies or may take (in a few cases) advanced diving courses. Certification by a national recreational diver training organization is common.

Research Consortia Diving

Seven of nine listed research consortia responded, of these, six reported diving activities. A total of six members of the professional staff and forty-one students reportedly used diving, with a total of three support/helper divers. The reporting consortia are composed of colleges and universities in a geographic area and are staffed substantially by university personnel. Hence, the number of individuals and fields associated with the consortium as an institution is small. The geographic distribution for research consortia divers and associate degree institution divers is summarized in Table 16.

TABLE 16

Divers at Associate Degree Awarding Institutions
and Research Consortia by Geographic Area

	East Coast	West Coast	Gulf of Mexico	Great Lakes & Inland	Total
Professional Staff	15	15	10	5	45
Students	50	170	15	15	250
Support/Helpers	<u>15</u>	<u>5</u>	<u>5</u>	<u>--</u>	<u>25</u>
Total	80	190	30	20	320

NON-MILITARY GOVERNMENTAL DIVING

Introduction

Initially it was expected that the analysis would reveal two types of divers, those whose duties were primarily diving (such as ship repairs and the like) and those who use diving as a tool to support their primary vocation (e.g., geology, fisheries, engineering, etc.). It became apparent that this differentiation is not workable because diving, qualitatively, is seldomly a sole duty and information is not maintained by agencies in such a manner to make this differentiation.

Categorizations within the field of diving were made to facilitate data acquisition and analysis. At a Federal level, only a limited number of agencies and activities have marine science and engineering missions. Neither the Civil Service Commission nor any other agency was found to maintain a central source of information on diving. The MUS&T Program however had completed an assessment of Federally sponsored use of manned undersea facilities for the Interagency Committee on Marine Science and Engineering (ICMSE), which provided a good starting point for a canvass of Federal agencies using diving. A distinction was made between "State and Local" diving and diving by police and fire departments primarily because of the differences in purposes and the availability of information.

Federal Agency Data Collection

Twelve Federal agencies have marine science and engineering missions and are members of ICMSE, these include two Department of Defense activities (the U.S. Navy and Army Corps of Engineers), and the Coast Guard. The Corps of Engineers was included in the assessment of non-military diving since its diving is performed in conjunction with civil works programs. The Coast Guard reports to the Secretary of Transportation and was also included in the following list of ICMSE agencies (Intergovernmental Committee on Marine Science and Engineering).

Army Corps of Engineers, Civil Works Directorate (COE/CW)
Department of Commerce (National Oceanic and Atmospheric Administration
[NOAA] and Maritime Administration [MARAD])
Department of Health, Education and Welfare (HEW)
Department of the Interior (Geological Survey [USGS], Bureau of
Sport Fisheries and Wildlife [BSFW], Bureau of Mines [BuMines],
Bureau of Land Management [BLM], National Park Service [NPS],
and Bureau of Outdoor Recreation [BOR], Bureau of Reclamation [BR])
Department of State (State)
Department of Transportation (U.S. Coast Guard) [USCG]
Atomic Energy Commission (AEC)
Environmental Protection Agency (EPA)
National Aeronautics and Space Administration (NASA)
National Science Foundation (NSF)
Smithsonian Institution (SI)

No divers were reported by MARAD, BuMines, BLM, BOR, State, AEC, NASA, and NSF. It should be noted that the inquiry concerned diving by employees of the agency, not the use of diving. For instance, AEC sponsors work which involves diving, but such diving is performed by contractors or grantees. The same is true for NSF. The NASA uses Navy and contractor divers. Hence, a report of "no divers" does not necessarily imply "no diving" in support of an agency's mission.

Contacts with an agency occasionally provided a lead to a "non-marine science and engineering" activity which used divers. Federal law enforcement agencies, such as the Bureau of Customs, Border Patrol, and Federal Bureau of Investigation were also contacted. These agencies depend on either Navy or Coast Guard divers when diving is required.

Federal Agency Divers

Agencies vary with regard to the degree to which information on diving is centralized. NOAA has an agency-wide coordinator and regional coordinators. Each NOAA diver receives a letter authorizing he or she to dive on "official business." The Office of the Chief Engineer, Corps of Engineers, annually collects statistics on Corps-wide diving. The Coast Guard keeps track of diver "billets." For EPA, it was necessary to survey each Regional Administrator and each Research Center.

The number of divers reported by each agency by region are shown in Table 17. Because of the decentralization of statistics on diving and the number of agencies and activities involved, a small number of individuals may have been missed but it is unlikely that an activity with a large number of personnel who dive was missed. It should be noted that individuals were recorded on the basis of the geographic location of their duty station, not where the diving is conducted.

TABLE 17

Federal Agency Personnel Using Diving By Geographic Region

	Coast	Coast	Gulf of Mexico	Great Lakes & Inland	Total
Department of Commerce, NOAA	63	97	53	2	215
Army Corps of Engineers	28	14	26	69	137
Environmental Protection Agency	21	16	15	14	66
Department of Transportation, USCG	13	34	9	8	64
Department of the Interior	0	24	6	30	60
Smithsonian Institution	36	0	8	0	44
TOTAL	<u>161</u>	<u>185</u>	<u>117</u>	<u>123</u>	<u>586</u>

Types of Diving for Federal Agencies

Concentrations of individuals certified to dive for NOAA are found in the National Ocean Survey (NOS) and National Marine Fisheries Service (NMFS). The dives in NOS are, for the most part, officers in the uniformed NOAA Corps and their efforts are associated with ship operations and NOS's hydrographic and oceanographic surveys. In NOS, work includes doing field repairs, installing instrumentation, identifying obstructions located by two ships in wire-drag surveys of navigation areas, and the acquisition of scientific data. In NMFS, diving is associated primarily with research concerning fish, fishing equipment and ecology. Other NOAA divers are associated with the Environmental Research Laboratories and MUS&T Program. In the latter case, divers do engage in operational research missions, but mainly review and manage programs using manned undersea activities. For most NOAA personnel, diving is a support tool, not their principal function.

Corps of Engineer (COE) divers are associated with Waterways Experimental Stations, Coastal Engineering Research Centers, in the following regions, Lower Mississippi Valley, North Atlantic, North Pacific, Ohio River, Pacific Ocean, South Atlantic, South Pacific, and South West. Those who dive are concerned with inspections and COE public works projects, such as shoreline and harbor protection, dams, and canals. In the COE, as in NOAA, diving is usually a support tool for personnel with other technical specialities.

Coast Guard divers primarily perform hull inspections and minor underwater ship repair work and, to a lesser extent, bottom surveys, underwater search and salvage, research, aid-to-navigation inspections and pollution monitoring and control operations. Approximately half of the diving billets are aboard ship.

In DOI, the USGS, BSWF, NPS, and BR diving by employees, was also reported to be a tool, not a speciality. At USGS, geologists use diving in the study of sediments and mineral resources. The BR has six teams composed of geologists and engineers which inspect dams and other public works in the western states. Biologists with the BSWF and NPS also use diving.

Six of ten EPA regions and two of three National Environmental Research Laboratories report the use of diving. Approximately three-quarters of the personnel have technical specialities and use diving as a support tool, while the others are support personnel. Diving is used both in monitoring efforts and for research.

Most diving for the Smithsonian is performed by individuals associated with cooperating institutions and foundations. However, some individuals associated with the Smithsonian itself dive in the course of their studies of living resources, ecology, and natural history.

Federal Agency Training

The Coast Guard exclusively uses Navy diving schools, specifically the Navy Ship Salvage Diving Officer School, the Navy Diver Second Class School, and the Navy Scuba Diver School. Divers in other agencies receive training from a variety of sources. For instance, for Corps of Engineers divers, approximately fourteen per cent had Navy training, nine per cent commercial diving school training, fifty-one per cent recreational diving training, and twenty-six per cent had no formal training. At NOAA, employees who dive must have at least the equivalent of recreational diver training, a physical exam, and generally at least fifteen open-water dives before fully participating in operational dives. Additional requirements are imposed for saturation diving and the use of closed circuit systems. Requirements are judged on a case by case basis by a regional diving coordinator.

NOAA Regional Diving Coordinators are frequently called upon to assist other agencies in the certification of their divers. The divers are certified by their own agency, not NOAA. The EPA and BLM have requested and received such assistance from NOAA.

Divers remain certified primarily through regular diving. Continued training, through regular meetings and seminars, is limited.

State and Local Data Collection

As previously noted, police and fire department diving will be discussed separately. To develop an estimate of divers associated with state and city agencies, the NBS contacted agencies of twenty-five states and in twenty-one major cities and counties in coastal and Great Lakes regions.

Three problems were encountered, the first being that diving is seldom an exclusive duty, but rather is a skill used by certain employees with technical backgrounds to accomplish elements of their work. Secondly, the use of diving is generally handled less formally than in Federal agencies, with a resultant lack of centralized compilation of operating records. In addition, knowledge of the use of diving within agencies is limited.

Three basic types of agencies and departments which use diving services, were identified:

1. Law enforcement agencies or departments.
2. Conservation, environmental protection, civil works or park agencies or departments.
3. Fishery, wildlife, or game and related enforcement agencies and departments.

Other agencies or departments reported using divers include: public health, water resources, dam safety, and education.

State and Local Divers

It was learned that cities, counties, port authorities, and other local jurisdictions obtain required diver services either through contracting or from the local police or fire department. The work generally consists of inspection and minor repair of public facilities. Large jobs are almost always contracted.

Table 18 provides the information reported to TAD by organizations in twenty-five states. All contacts reported the use of diving services, and seventeen had employees who performed diving. Nine of the seventeen reported over ten employees who dive. It is interesting to note that twenty states, including twelve of those with employees in other departments who dive, contract their highway department diving work.

Alaska, Georgia, Hawaii, New York, Rhode Island, South Carolina, and Virginia were not contacted nor were eighteen non-coastal states. Assuming that Alaska, Hawaii, New York, and Rhode Island have on the average at least the number (seventeen employees) who on the average dive in the New England states, and that Georgia, South Carolina, and Virginia average the same number (seven) as the other Middle Atlantic States, and that uncontacted inland states average two employees, the following regional distribution can be computed:

East Coast	130
West Coast	110
Gulf of Mexico	45
Great Lakes and Inland	<u>50</u>
TOTAL	335

It is believed that a thorough canvass would reveal a total number of divers of at least three hundred, and unlikely more than five hundred.

State and Local Training

Of those states reporting training, only Maryland relies exclusively on Navy diving schools. The remainder have their own programs (some using ex-Navy divers as instructors) or require national recreational diver training organization certifications. States with ten or more diving employees generally conduct training sessions on a regular basis (semi-annually, quarterly, or monthly). This is also done by some states with fewer divers.

Table 18

Employees Who Dive Reported by States

State	High- way	Fish & Game	Cons. & Parks	Other	Total Reported	State	High- way	Fish & Game	Cons. & Parks	Other	Total Reported
Alabama	4	C	C	0	4	Minnesota	C	-	-	-	0
Arkansas	C	-	-	-	0	Mississippi	C	-	-	-	0
California	1	22	8	17	48	Nebraska	C	-	-	-	0
Connecticut	3	4	3	0	10	New Hampshire	C	3	0	0	3
Delaware	C	2	0	2	4	New Jersey	C	-	-	-	0
Florida	4	20	0	0	24	North Carolina	C	5	0	0	5
Illinois	C	-	-	-	0	Ohio	C	-	-	-	0
Indiana	0	-	-	-	0	Oregon	5	12	0	0	17
Louisiana	C	3	0	0	3	Pennsylvania	C	2	0	0	2
Maine	C	20	2	7	29	Texas	C	10	0	0	10
Maryland	C	0	8	0	8	Washington	C	15	0	0	15
Massachusetts	C	10	0	0	10	Wisconsin	C	3	2	1	6
Michigan	C	2	5	0	7	TOTAL	17	133	28	27	205

C - Contract out

- - Not Contracted

Police Department Diving

Police and fire departments personnel who dive are called upon to perform the following duties:

- Body recovery
- Evidence recovery
- Motor vehicle recovery
- Maintenance of small craft
- Support of other state and local agencies and departments

Diving is generally conducted on a voluntary basis in addition to regular duties.

NBS contacted 1,392 out of 12,842 (11%) law enforcement jurisdictions in a survey for the Department of Justice's Law Enforcement Assistance Administration (LEAA). The resultant information was used for estimates of the diving population supplemented with additional information after contacts with organizations such as the International Association of Chiefs of Police and National Sheriffs' Association failed to yield the desired quantitative data. One of the questions in the NBS survey specifically addressed the performance of underwater recovery operations. NBS wrote a computer program to count the number of positive responses and, from these, to project the number and types of jurisdictions which appear to perform such operations.

The LEAA survey used the ten standard Federal regions, shown in Figure 2. Within each region, the police jurisdictions were identified as: state, county, one of the "fifty largest cities" in the United States, city with a one-to-nine-man police force, ten-to-forty-nine-man police force, fifty or more-man police force, and townships. The overall sample design, was as follows:

<u>Type of Jurisdiction</u>	<u>Number of Jurisdictions</u>	<u>Number Sent Questionnaire</u>	<u>Per Cent Sent Questionnaire</u>
State	56	56	100
County	3137	300	9.6
"50 Largest Cities"	50	50	100
City (1-9)	5486	297	5.4
City (10-49)	1985	300	15.1
City (50 or more)	554	269	48.6
Township	<u>1574</u>	<u>120</u>	7.6
	12842	1,392	10.8

A maximum sample size for each type of jurisdiction within each region (with the exception of state police and the "fifty largest cities") was established, with random sampling. In four jurisdiction-region combinations, there were less than thirty jurisdictions of a given type providing 100% coverage.

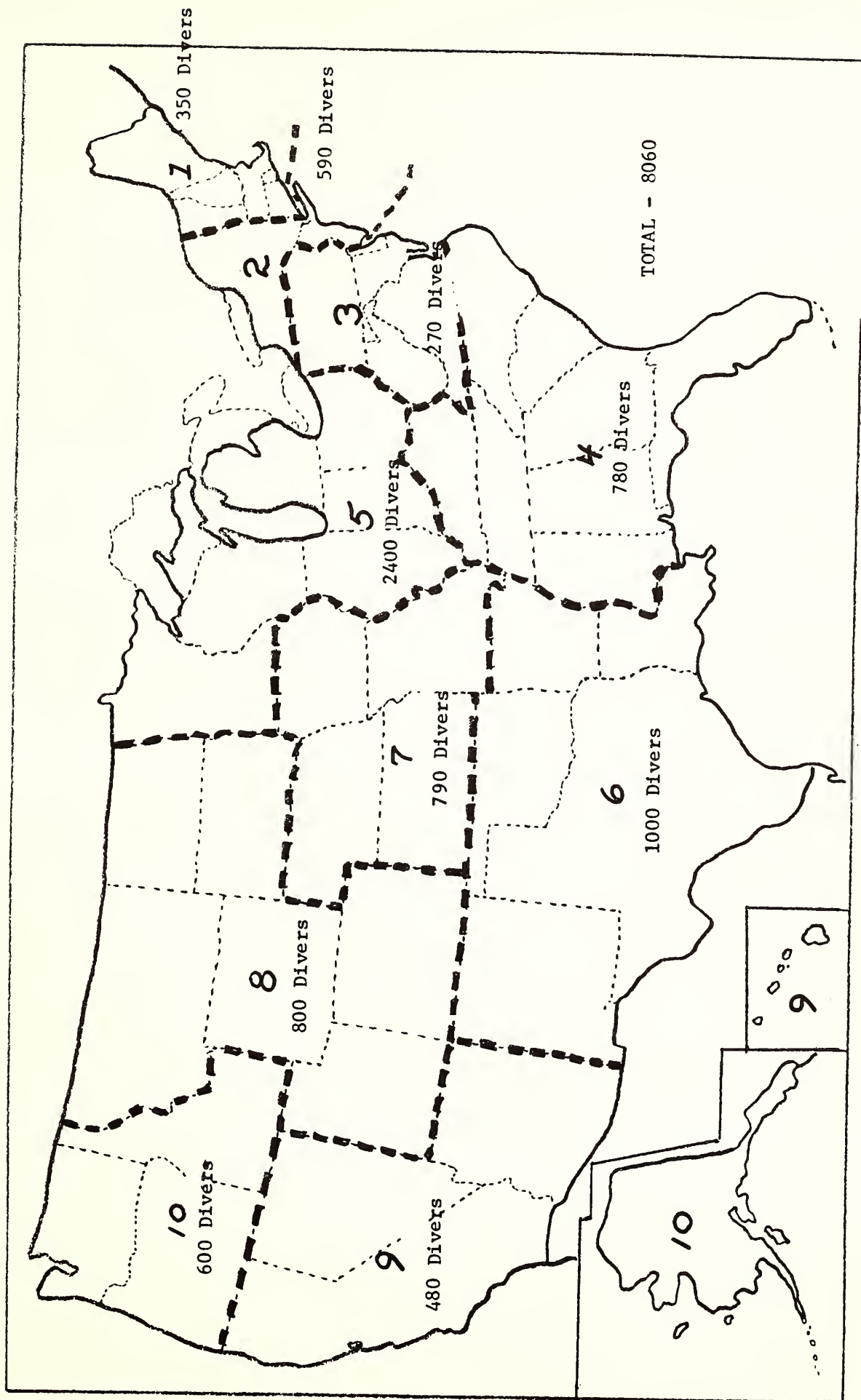


FIGURE 2 - REGIONS USED IN NATIONAL BUREAU OF STANDARDS POLICE DEPARTMENT ANALYSIS
AND ESTIMATED NUMBER OF DIVERS BY REGION

For only four jurisdiction-region combinations was the sample less than ten per cent, with most of these being a two per cent sample. The return rate was approximately eighty-four per cent for the state police departments, ninety per cent for the "fifty largest cities," and eighty-three per cent for the other types of jurisdictions. The returns were usually high, which is indicative of strong cooperation.

From the returns, the number of each type of jurisdiction in each region using diving was computed. The following departments and organizations were contacted to estimate the average number of divers in a department engaging in diving activity:

International Association of Police
National Sheriffs' Association
Calevares (CA) County Sheriff's Office
Atlantic City (NJ) Police Department
Chicago (IL) Police Department
Cleveland (OH) Police Department
Dade County (FA) Marine Patrol
Detroit (MI) Police Department
Deluth (NM) Police Department
Florida State Police
Houston (TX) Police Department
Los Angeles (CA) Police Department
Maryland State Police
Michigan Sheriff's Association
Michigan State Police
Milwaukee (WI) Police Department
Minneapolis (MN) Police Department
Nassau County (NY) Police Department
New Orleans (LA) Police Department
New York Police Department
New York State Police
Philadelphia (PA) Police Department
Ramsey County (MI) Sheriffs' Office
St. Paul (MI) Police Department
San Francisco (CA) Police Department
San Diego (CA) Police Department
Seattle (WA) Police Department
Suffolk County (NY) Police Department
Public Technology, Inc.

Each organization was asked not only about its own jurisdiction, but also about any others in the area or region with which they were familiar. For those departments having a diving activity, the following are the (approximate) average numbers of officers who dive:

<u>Type of Jurisdiction</u>	<u>of Divers</u>
State	20
County	5
City (1-9 Officers)	2
City (10-49 Officers)	4
City (50 or more Officers)	6
50 Largest Cities	10
Townships	2

While these numbers are estimates, they are most probably conservative. The results for each region based the sampling and averages are shown in Table 19.

Table 19

Estimated Number of Policemen Who Use Diving by Region*

	1	2	3	4	5	6	7	8	9	10	TOTAL
Total No. in Region Responding	116	129	128	113	136	105	100	103	117	95	1142
Total No. in Region Reporting Diving	20	26	16	15	33	14	14	19	26	34	217
Implied No. in Region with Diving	101	160	35	170	627	221	157	167	100	133	1871
Implied No. Divers	350	590	270	780	2400	1000	790	800	480	600	8060

* Region numbers correspond to those shown in Figure 2.

The total number of divers estimated in Table 19 (i.e. 8060) has been allocated to geographic areas, in rough proportion to state populations, and in accord with significant bodies of waters in or adjacent to the states. This crude process yielded the following result for police department divers:

East Coast	1260
West Coast	1670
Gulf of Mexico	900
Great Lakes and Inland	<u>5230</u>
TOTAL	8060

It is believed that the actual number is most likely at least as large as 6500 and not more than 9700.

Fire Department Diving

In the course of exploring diving statistics for fire departments, TAD contacted a variety of organizations, such as the International Association of Fire Fighters, National Fire Protection Association, and University of Maryland Fire Safety Department. As with police officers and others reported on earlier, firefighters who are assigned normal duties may occasionally be

called upon to dive. In general, firefighters who dive tend to be associated with rescue squads, life saving, maintenance and repair of fireboats, motor vehicle recovery and support of the police department or other local agencies. Divers generally use Scuba to depths not exceeding sixty feet.

NBS questions regarding fire department diving were also addressed to police departments. The following fire departments were contacted:

Anne Arundel County (MD) Fire Department
Boston (MA) Fire Department
Chicago (IL) Fire Department
Howard County (MD) Fire Department
Los Angeles County (CA) Fire Department
Mulwaukee (WI) Fire Department
New York (NY) Fire Department
Prince Georges County (MD) Fire Department

The number of firefighters who use diving can only be estimated in the absence of broad sample data (such as was available through the LEAA efforts). Such estimates are further complicated because of the number of volunteer companies and unaffiliated volunteers. The consensus of the various organizations, police departments, and fire departments contacted is that there are about one-hundred firefighters who dive per state. Assuming that this "average" applies to all states, the following regional estimates are made:

East	1300
West Coast	500
Gulf of Mexico	500
Great Lakes and Inland	<u>2700</u>
TOTAL	5000

Police and Fire Department Training

Police officers and firefighters obtain diving training through the Navy, commercial diving schools, and recreational diver training organizations. Most personnel volunteer for diving as an additional duty; hence, they tend to be recreational divers and were initially trained as such. Large departments customarily hold periodic training sessions or seminars for personnel who dive. Such sessions only encompass a total of approximately 1,000 police officers associated with state police and the fifty largest cities which use diving, and perhaps 25-50% of the approximately 5200 police officers associated with counties using diving. Similar ratios may be assumed for fire departments.

Non-Military Governmental Diving Expenditures

Diving by non-military governmental personnel is conducted on an intermittent, rather than a regular basis. An individual might not dive for a period of perhaps six months, but then dive nearly every day for two or three weeks. This can be attributed to diving being a tool rather than a vocation among

such individuals. Thus, all contacts were hard pressed to cite an average number of diving days per year per individual. As in the case of scientific/educational institutional diving, it was decided to estimate the direct expenditures on diving rather than attempt to include a dollar value for the program for which the diving is conducted.

Information furnished by Federal agencies and state and local agencies (excluding police and fire departments), suggests that the average individual who dives does so on fifteen to twenty-five days per year. Using a cost figure of \$25 per day per individual, yields an estimated expenditure of \$460,000. To this must be added approximately \$600,000 per year NOAA contributes to facilities which support NOAA and other Federal divers. Thus, conservatively, direct annual expenditures in these categories for diving are approximately \$1.1 million. Assuming that new and replacement equipment is purchased annually as employees commence diving and equipment wears out, using a cost figure of \$200 per year per employee yields an estimated expenditure of another \$187,000.

A consensus among police and firefighter information sources was that there was an average of approximately ten dive-days per individual per year. Using the \$25 per dive cost figure yields an estimated annual expenditure of \$3.3 million. If a similar assumption on equipment replacement is made for police and fire departments as for other government agencies, there is an estimated \$2.6 million in expenditures for this purpose.

RECREATIONAL DIVING

Introduction

In diving, as in many sports, there are a large number of persons with skills necessary for participation, but a lower number who participate regularly. Training for recreational diving can be obtained from a number of sources, including national recreational diver training organizations, government organizations, military services, independent clubs and organizations, or from a friend. There is a tendency for more and more individuals to obtain training from a nationally recognized source, possibly because more dive shops are requesting evidence of such certification prior to providing air. There is a problem in identifying the total number of individuals with diving skills who "dive regularly" or who are "active." For this analysis, it was easier to define a "dropout:" an individual who completed training and essentially stopped diving after the novelty wore off. Subtracting "dropouts" from those with diving skills yields "individuals practicing the sport."

No definitive census of recreational divers has ever been taken. The April, 1970, Marine Science Affairs, the Annual Report of the President to the Congress on marine resources and engineering development, contained estimates of 1.5 million and 2.0 million active Scuba divers (pages 106 and 107). For this analysis, two sources were used: the major recreational diver training organizations and the Skin Diver Magazine reader survey of 1972.⁴

Recreational Diver Training Organizations

The Skin Diver survey showed that 86.9 per cent of the sampled readers with formal training were trained by one (or more) of five major organizations, namely:

Young Man's Christian Association (YMCA)
National Association of Underwater Instructors (NAUI)
Professional Association of Diving Instructors (PADI)
National Association of Skin Diving Schools (NASDS)
Los Angeles County (LA Co.)

Telephone contacts were made with each of these organizations to obtain information on the number of individuals trained during 1972, 1971, and in 1970 and earlier. Each was also asked about dropout rates and the geographic distribution of instructors and students. Table 20 summarizes the reported training and provides the percentage of the total reported by each of the five, as well as the percentage of Skin Diver readers who reported training by the organization.

⁴ "1972 Skin Diver Reader Survey," Peterson Publishing Co., 16 pp.

Table 20

Training Reported by Major Recreational Training Organizations
and Training Reported by Skin Diver Readers⁵

Organization	1970 and Before	(In Thousands)			% Trained by Each	% of Skin Diver Readers	Organization Total ÷ Frac- tion of Skin Diver Readers
		1971	1972	Total			
YMCA	172	12	42	226	20.7	29.4	769
NAUI	212	54	67	333	30.4	30.0	1110
PADI	47	37	52	136	12.4	9.9	1374
NASDS	133	52	55	240	21.9	12.2	1967
LA Co.	140	10	10	160	14.6	5.4	2963
TOTALS	704	165	226	1,095	100.0	86.9	-

Computation of Individuals with Diving Skills

If it is assumed that the sample drawn from the readership of Skin Diver Magazine is representative of the persons with diving skills in general, then the total trained population can be estimated by dividing the total number trained by a given organization by the fraction of Skin Diver readers trained by that organization. Using this technique for the organizations listed yields five estimates of the population; ranging from nearly 0.8 million to nearly 3.0 million. These can then be weighted according to the contribution of the individual organization to the combined total, yielding a single estimate of the trained population of approximately 1.5 million. This must be added an estimate of the population without formal training.

In mathematical terms, this rather crude estimation process is as follows:

$$\text{Total Population} = (1 + I) \sum_i \left(\frac{T_i}{P_i} \right) W_i$$

Where: T_i = total number of individuals trained by training organization "i"

P_i = percentage of Skin Diver readers trained by training organization "i"

W_i = percentage of total training reported for the analysis by training organization "i"

I = ratio of untrained to trained individuals reported by Skin Diver readers⁵ (17.3/82.7)

⁵ Ibid, page 44

The foregoing computation leads to an estimate of 1,890,000 individuals with diving skills. More than likely there are individuals trained by more than one of the listed organizations. However, this effect is believed to be minimal in that only major, national organizations were considered in the procedure. Multiple counting would have been more serious if independent operations had also been used. The actual population is believed to be not less than 1.5 million nor more than 2.1 million.

Recreational Diving Dropouts

A dropout diver is one who stops diving soon after completing training. Because of this, the number of persons "practicing the sport" is somewhat less than the number with skills.

The recreational diver training organizations contacted estimate that the "dropout" rate lies somewhere between 22% and 95%. However, they indicate that this rate is decreasing substantially. Two explanations are offered, both associated with changes in training programs. Courses have been lengthened and made more difficult. Thus, an individual has to have a greater commitment than in the past to complete training and also has invested more time and effort. Secondly, a greater number of open water dives, particularly in the ocean, during training builds confidence and tends to get individuals "hooked."

The individual estimates of dropout rate by the training organizations contacted were weighted in their fraction of the total training reported. This results in an estimate of 74.9% for the dropout rate. Stated conversely, about 25% of those trained actually practice the sport. Thus, of 1,890,000 trained, about 474,000 actually practice the sport.

Geographic Distribution

Training organizations were also queried about the geographic distribution of their instructors and trainees. It was generally agreed that California has the greatest number of divers and a relatively distant second was Florida. Other states with significant numbers of divers were identified as follows (in alphabetical order): Hawaii, Massachusetts, New York, Texas and Washington.

Based on percentages furnished by the training organizations, a rough allocation of the "individuals with diving skills" and of "individuals practicing the sport" was made to the four regions used throughout this analysis. Data being developed (such as NAUI's planned analysis of instructors and trained individuals by zip code) should permit better analyses to be made in the future. Table 21 give the estimates on a regional basis.

Table 21

Estimated Recreational Divers By geographic Area

	East Coast	West Coast	Gulf of Mexico	Great Lakes & Inland	Foreign	Total
Individuals With Diving Skills	300,000	790,000	480,000	290,000	30,000	1,890,000
Individuals Practicing the Sport	75,000	198,000	120,000	73,000	8,000	474,000

Expenditures on Recreational Diving

A wealth of information on equipment and expenditures was collected by Skin Diver's reader survey. It was estimated that their primary readers spent over \$44.5 million dollars on diving trips in a twelve month period.⁶ If it is assumed that the estimated 474,000 persons dive at least once per month over a year or at least twelve days per year (Skin Diver readers reported diving on an average of 24.7 days⁶) and that each spends \$25 per day on direct diving expenses, the minimum expenditure would be \$142.2 million. Adding the cost of travel, lodging, and meals, expenditures on diving and related activities are probably well in excess of \$186.7 million.

To direct expenditures must also be added equipment purchases. There are perhaps five basic types of purchases: initial equipment (such as fins, mask, snorkel, and life vest; basic equipment such as a weight belt, knife, pressure gauges, watch, and dive gear bag); advanced equipment (such as a wet suit, tanks, and regulator); accessories (such as underwater lights, cameras, underwater scooters, compressors) and replacement equipment. The standard industrial codes used by the Government for industrial statistics do not permit the differentiation of diving equipment information, hence a combination of assumptions, estimates, and Skin Diver survey information has been adopted.

Approximately 226,000 individuals were trained during 1972 by the recreational diver training organizations contacted. Applying the percentages of individuals trained by these organizations and those not trained by them as derived from the Skin Diver survey yields, an estimated annual training level of approximately 260,000. If each individual purchases entry level equipment (which is likely because of greater emphasis on open water dives during training), consisting of a mask, snorkel, fins, and life vest at an approximate cost of \$50, such expenditures would total \$13 million. If forty per cent go further, at least temporarily, they would probably spend an additional \$400 or so on basic and advanced equipment, resulting in an additional annual expenditure of \$41.6 million.

Diving Safety

The University of Rhode Island (URI) has conducted studies of underwater fatalities at a modest level since 1970 and has been sponsored since 1972 for data collection by a cooperative effort of NOAA, the Coast Guard, and the Navy.

The URI study determined that in calendar year 1971 there were one hundred and sixteen fatalities which involved diving with compressed gas (mostly Scuba). The studies determined that in calendar year 1972 there were one hundred and twenty fatalities involving diving if three "special nature" fatalities are excluded. (These "special nature" fatalities included a diving team which perished while attempting to set a depth record using air and an individual killed by an exploding compressed air cylinder in a

⁶ Ibid, page 3 .

compressor room.) Ideally to measure fatality rates and the improvement or decline of safety, a measure such as fatalities per million dive-hours or something similar should be used. At worst, a measure such as fatalities per total individuals involved could be used; although this is a weak measure since it does not include a measure of activity or differing hazards in different areas or types of diving. Unfortunately, statistics on diving are inadequate to permit accurate assessments of safety.

There is an indication that diving is becoming safer. For instance, if fatality rates are computed for 1971 and 1972 using estimates for each year of "Individuals Practicing the Sport," there is a decrease in the rate of over fifteen per cent. A decrease in the rate of approximately one-third can be shown if the base number divisor in rate computation is taken as the sum of the "Individuals Practicing the Sport" for the prior year and the total trained in the current year (i.e., in computing the rate of 1972, the one hundred and twenty fatalities would be divided by the sum of the computed "Individuals Practicing the Sport" for 1971 plus the individuals trained during 1972).

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